

RESEARCH ARTICLE

A new greenhouse invader: the first report of the alien ring-legged earwig, *Euborellia annulipes* (Dermaptera, Anisolabididae) in Serbia, with the first checklist of earwigs of the country

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Abstract

The ring-legged earwig *Euborellia annulipes* (Lucas, 1847) is recorded for the first time on the territory of Serbia. The species was found in the greenhouse of Jevremovac Botanical Garden in Belgrade and represents the second allochthonous invertebrate species registered in this greenhouse, after an exotic millipede. In total, 10 specimens of ring-legged earwig were found in the sections of the greenhouse where tropical and subtropical plants are cultivated. The first checklist of earwigs of Serbia was compiled and notes on autochthonous species are given.

Keywords

Allochthonous, botanical garden, insect, invasive species.

Introduction

Earwigs (Dermaptera) are a small insect order, represented by about 2,000 species, divided into 11 families (Kočárek et al. 2013). There is only a small number of synanthropic species, originating mostly from subtropical and tropical parts of the

world. European earwig *Forficula auricularia* Linnaeus, 1758 is the most notable synanthropic non-tropical species, now introduced in North America (Kočárek et al. 2013). In Europe, there is four earwig families, viz. Anisolabididae, Forficulidae, Labiduridae and Spongiphoridae, among which eight species are allochthonous, and many of them are synanthropic and can be found inside greenhouses or similar buildings with suitable living conditions: *Euborellia annulata* (Fabricius, 1787), *E. annulipes* (Lucas, 1847), *E. arcanum* Matzke & Kočárek, 2015, *E. femoralis* (Dohrn, 1863), *Forficula lucasi* Dohrn, 1865, *Marava arachidis* (Yersin, 1860), *Nala lividipes* (Dufour, 1828) and *Paralabellula curvicauda* (Motschulsky, 1863) (Harz and Kaltenbach 1976; Kočárek 2009; Rasplus and Roques 2010; Matzke and Kočárek 2015; Matzke 2018; Kalaentzis et al. 2021; Zafeiriou et al. 2021).

Ring-legged earwig, belongs to the family Anisolabididae, possibly originated in East Africa or the Mediterranean. Today, *E. annulipes* is spread all over the world, including many European countries (e.g. Koppenhofer 1995; Kočárek et al. 2015; Murányi and Puskás 2018). The species occurs outdoors in warmer regions of Europe, while it is usually found inside heated greenhouses in colder regions of the continent (Albouy and Caussanel 1990; Kočárek et al. 2015; Lock 2016). Ring-legged earwig is an omnivore, and various authors studied the impact of this species in terms of both causing damage to plants, and predation of plant pests (e.g. Bharadwaj 1966; Koppenhofer 1995). It is known that it can inflict damage to plants, feeding on both underground and aboveground plant parts, and it is registered as a pest of stored sweet potato *Ipomoea batatas* (L.) Lamk (1793) (Gould 1948; Bharadwaj 1966). However, studies have shown that this species is also effective in controlling the number of some plant pests, e.g. banana weevil *Cosmopolites sordidus* (Germar, 1824), fall armyworm *Spodoptera frugiperda* (Smith, 1797), or diamondback moth *Plutella xylostella* (Linnaeus, 1758) (Koppenhofer 1995; Silva et al. 2009; Nunes et al. 2020). Kočárek et al. (2015) found that in a greenhouse conditions, *E. annulipes* is omnivorous but with a predominantly herbivorous diet, which makes it a potential pest, especially of seedlings and plants with soft tissues.

The data about the earwig fauna of Serbia is scarce since extensive research on these insects has never been conducted. Relatively large dataset on occurrence and distribution of earwigs in Serbia exists in the Alciphron database of insects of Serbia, which is one of the well-known online platforms for collecting georeferenced data on insects in the country (Vujić 2022).

The Jevremovac Botanical Garden in Belgrade was founded in 1874, firstly at Dorćol, on the right bank of the Danube. Since the original location was prone to floods which destroyed the entire plant collection, the botanical garden was moved to its current location in the city center in 1889. Currently, the Jevremovac Botanical Garden covers an area of 4,82 hectares, including an open area with Japanese garden and the greenhouse (Fig. 1). An open area of the garden contains a plant collection of about 1,300 species, originating from various parts of the world. The greenhouse was founded in 1892, in Victorian architecture, and it consists of a central dome and two wings, covering a total area of 550 m². The greenhouse was thoroughly restored

in 2014, after which it was opened for visitors. The central dome and the left wing are areas where subtropical and tropical flora originating from around the globe are cultivated. In the right wing, Mediterranean plants, cacti and other succulents are grown (Jovanović 1998; Botanička bašta Jevremovac 2022).

Material and methods

The survey was conducted on April 13, 2022 in the greenhouse of Jevremovac Botanical Garden with the aim of finding and recording non-native invertebrate species. Specimens were collected by hand and using entomological tweezers. Identification of species was performed using the keys provided in Kalaentzis et al. (2021). Given that *E. annulipes* is considered a new model for insect oogenesis and developmental biology research (Núñez-Pascual et al. 2022), one male and one female were left alive and are currently being held at the University of Belgrade - Faculty of Biology, for the purpose of establishing the population for future research. Photograph

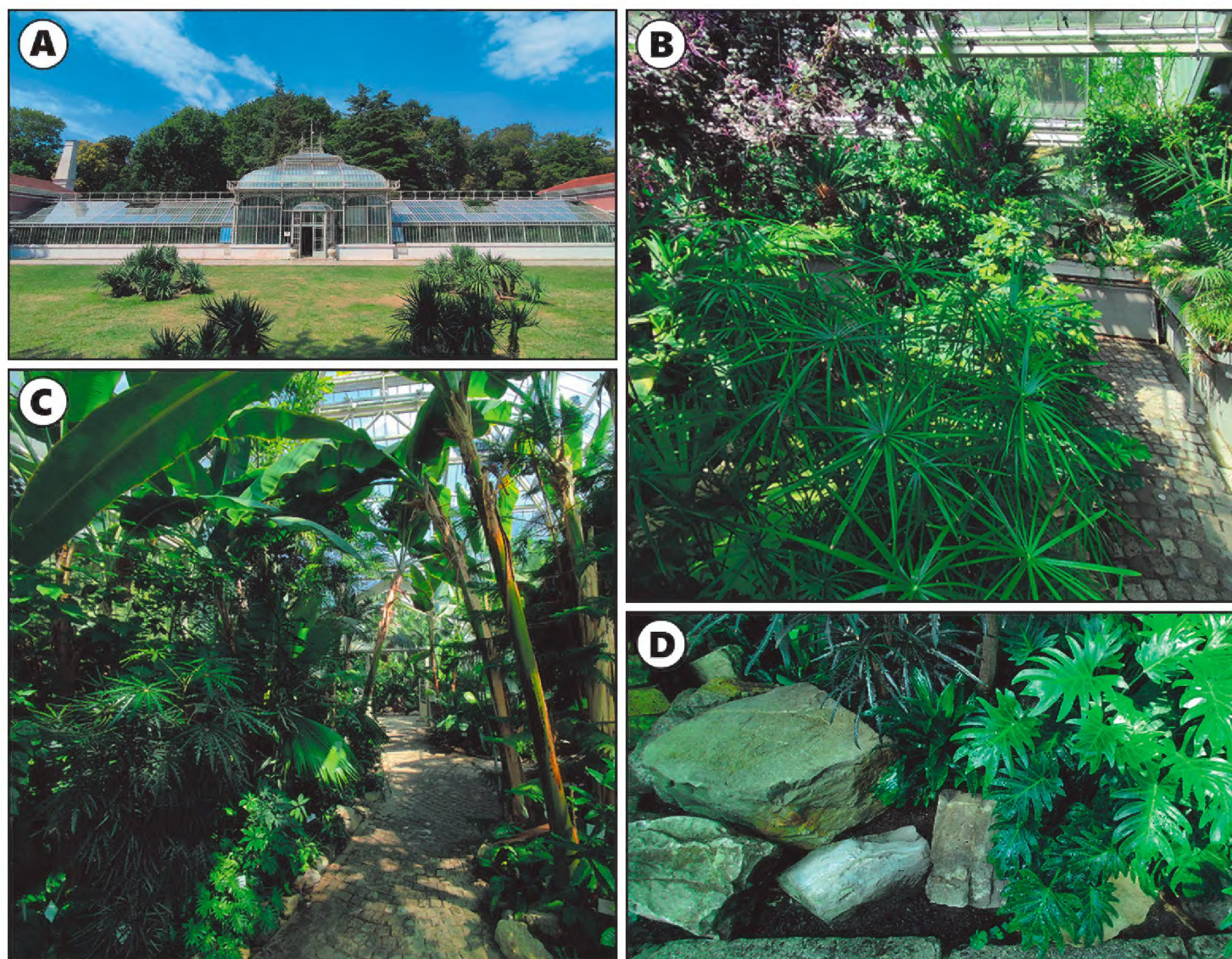


Figure 1. The greenhouse of Jevremovac Botanical Garden, Belgrade, Serbia. **A** - seen from the outside; **B** - inside of the “tropical” left wing; **C** - inside of the “subtropical” central dome; **D** - rocks in the central dome, under which a few specimens of *Euborellia annulipes* (Lucas, 1847) were found (photo: N. Vesović).

of the earwig specimens were taken using a Nikon D5300 digital camera equipped with Tamron SP 90mm f/2.8 Di Macro lens and Sigma EM-140 DG ring flash.

The up to date checklist of Dermaptera of Serbia was made using the literature data, published articles and the Alciphron database of insects of Serbia (Živojinović 1950; Jakšić et al. 2006; Murányi 2013; Vujić 2022).

Results

Euborellia annulipes (Lucas, 1847) (Fig. 2)

Protonym:

Forficesila annulipes Lucas, 1847: 84, 85.

Synonyms:

Anisolabis annulicornis Blanchard, 1851

Anisolabis eteronoma Harz, 1975

Anisolabis fallax Shiraki, 1906

Anisolabis nana Boeseman, 1954

Anisolabis tripolitana Werner, 1908

Diplatys nana Burr, 1914

Forficesila annulipes Lucas, 1847

Forficula annulicornis Blanchard, 1851

Forficula equestris Gén  , 1837

Forficula variicornis Smidt, 1876

Material examined: Serbia • 2♂ 7♀ 1 nymph; Belgrade, Jevremovac Botanical Garden, greenhouse; 44.815894 20.473144; altitude 94 m.a.s.l.; 13 Apr. 2022; leg. M. Vujić, M. Maričić and M. Šević (specimens are stored in M. Vujić's private collection).

Remarks: In total, ten specimens (nine adults and a nymph) were collected during the survey conducted in the greenhouse of Jevremovac Botanical Garden in Belgrade (Fig. 1A), with the aim of searching for potential exotic invertebrates, such as insects, myriapods, mollusks, and spiders. Specimens of *E. annulipes* were found both in the tropical left wing (Fig. 1B) and the subtropical central dome (Fig. 1C) of the greenhouse, while the earwig was absent from the right wing, which is characterized by arid environmental conditions. All three parts of the greenhouse were separated by glass barriers, but doors between the sections are usually opened, which allows unimpeded movement of organisms. The presence of earwigs only in the left wing and the central dome of the greenhouse suggests that the species shows a preference for humid conditions. Specimens were found in and under rotten wood, beneath rocks (Fig. 1D) and in the soil.

Diagnosis: The ring-legged earwig is so far the only allochthonous dermapteran species registered in the entomofauna of Serbia and the only earwig species registered in the greenhouse of Jevremovac Botanical Garden. From autochthonous species of

dermapterans that are inhabiting Serbia, *E. annulipes* can be easily separated by general appearance, uniformly dark body color, except legs, completely reduced tegmina and wings (at least in specimens recorded in Europe) and bicoloured antennae – mostly black, with a few pale subapical antennomeres. From other *Euborellia* Burr, 1910 species recorded in Europe, *E. annulipes* can be separated using the identification key provided in Kalaentzis et al. (2021): tegmina and wings are fully missing, and the first antennomere is distinctly shorter than the length of antennomeres 2–4 combined.

Checklist of earwigs of Serbia

The up to date checklist of Dermaptera of Serbia contains eight species from all four families occurring in Europe (Anisolabididae, Forficulidae, Labiduridae and Spongiphoridae). Taxa whose presence in Serbia has not been confirmed by recent findings are marked with an asterisk (*).



Figure 2. Ring-legged earwig, *Euborellia annulipes* (Lucas, 1847), collected from the Jevremovac Botanical Garden in Belgrade. The scale bar is 5 mm (photo: N. Vesović).

Anisolabididae

1. *Euborellia annulipes* (Lucas, 1847) (Fig. 2)

Forficulidae

2. *Anechura bipunctata* (Fabricius, 1781)*
3. *Apterygida media* (Hagenbach, 1822) (Fig. 3A)
4. *Chelidurella acanthopygia* (Géné, 1832)
5. *Forficula auricularia* Linnaeus, 1758 (Fig. 3B)
6. *Forficula smyrnensis* Audinet-Serville, 1838 (Fig. 3C)

Labiduridae

7. *Labidura riparia* (Pallas, 1773) (Fig. 3D)

Spongiphoridae

8. *Labia minor* (Linnaeus, 1758)

Notes on autochthonous earwig species from Serbia

Anechura bipunctata (Fabricius, 1781)

The only earwig species in the fauna of Serbia whose status in the country is doubtful. The presence of *A. bipunctata* on the territory of Serbia originates from unverified data provides by Csiki (1923), mentioned in Murányi (2013), from the Autonomous Province of Kosovo and Metohija in the southern part of the country and confirmation of records is needed. This montane species is distributed from Central Mediterranean and Central Europe to Central Asia and usually occurs at high elevations (Országh et al. 2010; Murányi 2013). Although there are no recent records on the territory of Serbia, the presence of this species is probable, especially in the mountainous regions of eastern, southern and western parts of the country.

Apterygida media (Hagenbach, 1822)

This earwig species was recorded at several localities in Serbia, both in published records (at localities Krušedol at Fruška Gora Mt., Mosna and Dobra in Đerdap National Park and at Gamzigrad, near Zaječar in Murányi (2013)) and new records from Alciphron database (at localities Vrčin, Jelašnica, Niš, Banja Topilo and Majdanpek in Vujić (2022)). A small number of records indicate that *A. media* is not common in Serbia, although more detailed research is needed to gain insight into its real distribution in the country.

Chelidurella acanthopygia (Géné, 1832)

This dermapteran species was recorded at several localities in Serbia. Due to taxonomic problems within this genus, it is necessary to review material from Serbia, but also from the entire Balkans. Kirstová et al. (2021) have revised the taxonomic status of genus *Chelidurella* Verhoeff, 1902 and confirmed its generic status. The study did not analyze material from Serbia, but it was established that individuals from Croatia and Montenegro belong to the species *Chelidurella thaleri* Harz, 1980. These results partially confirmed the states from Murányi (2013), who found that specimens from Croatia (Dalmatia) and Montenegro do not completely comply with the *C. acanthopygia*, but remind more of *C. thaleri* Harz, 1980 and *Chelidurella guentheri* Galvagni, 1994, respectively. Kirstová et al. (2021) have also established that *C. guentheri* is synonym of *C. acanthopygia*, which additionally resolves the problematic situation of this genus. Given that no specimen from Serbia was analyzed in the aforementioned study, this genus still remains problematic in Serbia.

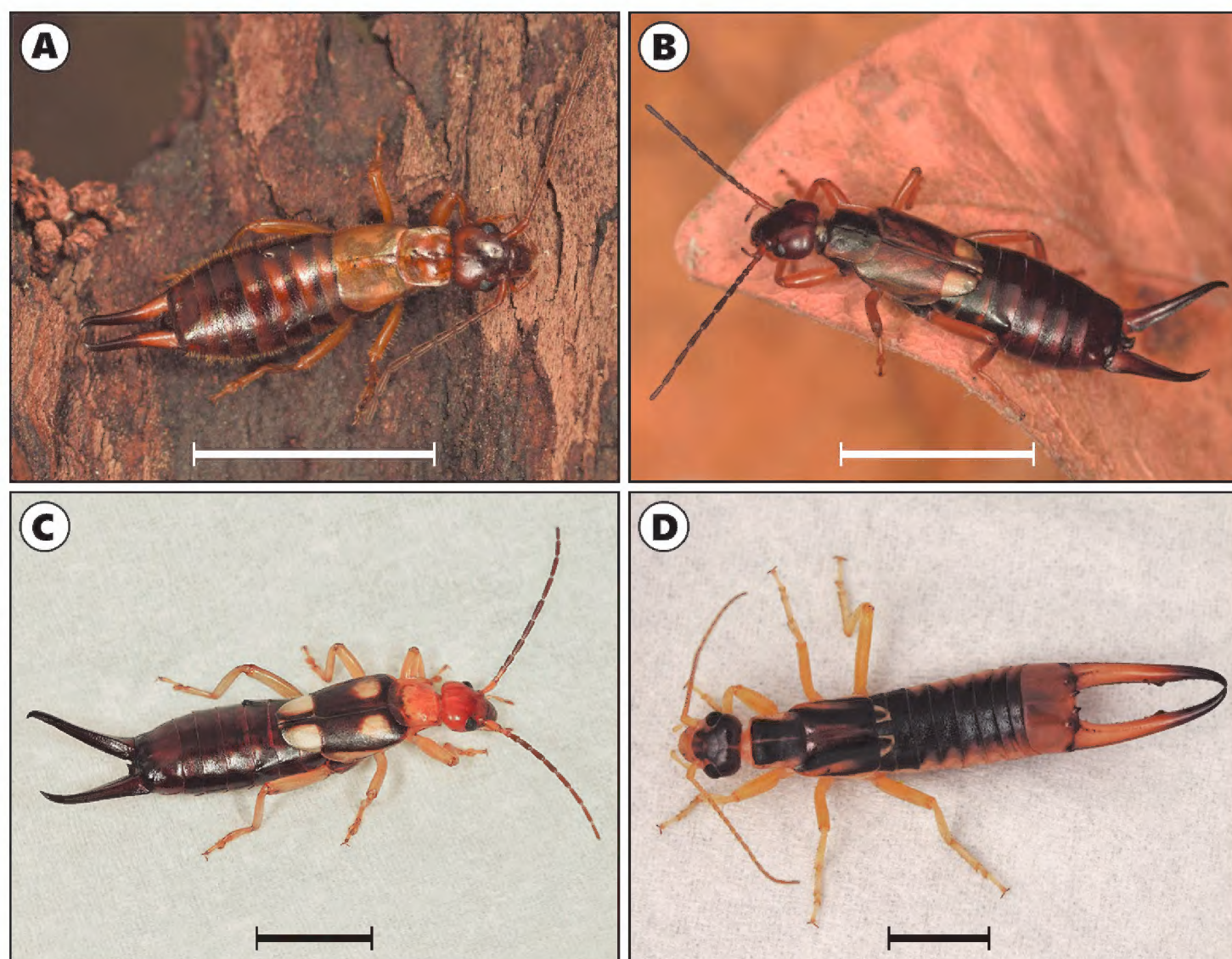


Figure 3. Some of the earwig species found in Serbia. **A** - *Apterygida media* (Hagenbach, 1822); **B** - *Forficula auricularia* Linnaeus, 1758; **C** - *Forficula smyrnensis* Audinet-Serville, 1838; **D** - *Labidura riparia* (Pallas, 1773). The scale bars are 5 mm (photo: N. Vesović).

Forficula auricularia Linnaeus, 1758

European earwig is the most common earwig species in Serbia, and its distribution covers entire territory of the country. It has been recorded in almost all types of habitats, from lowlands to the mountainous parts of the country. The species also shows a synanthropic character and is common in both rural and urban areas. It is characterized by gregariousness, so it happens that dozens of individuals can be found in a single place.

Forficula smyrnensis Audinet-Serville, 1838

A very common earwig species in Serbia, probably the most common after *F. auricularia*. It has been recorded in almost all parts of the country and is occasionally found in human settlements, but unlike the European earwig, *F. smyrnensis* is mostly found singly or as a small number of individuals.

Labidura riparia (Pallas, 1773)

A cosmopolitan earwig species, in Serbia it is recently recorded from two locations only, in Subotica Sandland (Subotička peščara) in the far north of the country and in the town of Kladovo on the right bank of the Danube, in the northeast of the country. Although *L. riparia* can currently be considered a rare species in Serbia, the lack of entomological surveys on sandy habitats, such as loess plateaus and sandy riverbanks, might be the reason for the lack of data on this species in the country.

Labia minor (Linnaeus, 1758)

An earwig species that was recorded at several localities in northern, central, western and southern parts of Serbia (Gakovo, Farkaždin, Bačka Palanka, Carska Bara, Zrenjanin, Banatski Dvor, Zasavica and Stajićevo in Autonomous Province of Vojvodina, Vrčin and Bogatić in central and western part of Serbia respectively and at Berivojce, in Autonomous Province of Kosovo and Metohija). It is the smallest earwig species in Serbia, which is most often recorded on light traps used in the research of moths and other nocturnal insects that are attracted by light.

Discussion

The ring-legged earwig is the first allochthonous dermapteran species recorded from Serbia, and the second recorded allochthonous species found in the greenhouse of Jevremovac Botanical Garden in Belgrade. Jovanović et al. (2016) registered the greenhouse millipede *Oxidus gracilis* (C.L. Koch, 1847) in the same greenhouse. Presence of these two allochthonous arthropods, well-known as invasive greenhouse

species, indicates the possible presence of a larger number of greenhouse invaders, and a detailed study of the greenhouse's fauna is required. For the purpose of getting to know the non-native fauna and potential pests of cultivated plants, further research is needed and future studies will be undertaken.

With this newly registered dermapteran, a total of eight species comprise the earwig fauna of Serbia. The presence of one of them is doubtful (*A. bipunctata*) and further research is needed to confirm its presence in Serbia. Also, since taxonomic status of *C. acanthopygia* in the Balkans is unclear, material from Serbia should be reviewed to gain an insight into the real status of said species.

In the last decade, many allochthonous and invasive species were recorded in Serbia, but usually outdoors, unlike *E. annulipes*. A large number of allochthonous insects species stand out, such as giant Asian mantid *Hierodula tenuidentata* Saussure, 1869, true bugs such as oleander seedbug *Caenocoris nerii* (Germar, 1847) and brown marmorated stink bug *Halyomorpha halys* (Stål, 1855), ragweed leaf beetle *Ophraella communa* LeSage, 1986, geranium bronze butterfly *Cacyreus marshalli* Butler, 1897, etc. (Šeat 2015; Šeat et al. 2019; Petrović-Obradović et al. 2020; Milojković et al. 2021; Vujić et al. 2021). In addition to insects, several species of other invertebrates have been reported, such as xerophilous snail *Xeropicta* cf. *krynickyi* (Krynicky, 1833), freshwater snail *Clathrocaspia knipowitschii* (Makarov, 1938), greenhouse millipede *Oxidus gracilis* (Jovanović et al. 2016; Gojšina et al. 2022; Szekeres et al. 2022 etc.).

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